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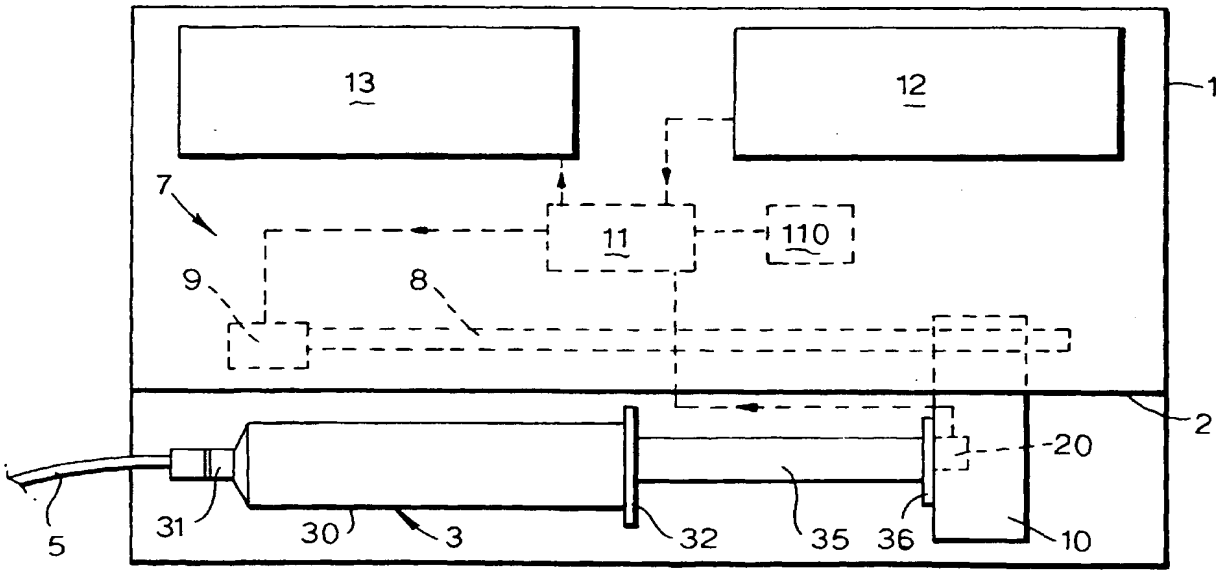
(54) Syringe pumps

(57) A syringe pump has a motor (9) rotating a lead-screw (8), which drives a plunger head retainer (10) to push a plunger (35) along the barrel (30) of a syringe (3) so as to dispense medication to a patient. A force sensor (20) in the head retainer (10) measures the force on the plunger (35) to detect when there is an occlusion restricting flow of medication. When an excess force is detected an alarm is generated and the motor (9) is reversed to reduce the force to about 10% of that at which the occlusion is detected. The occlusion can be removed with a reduced risk of a bolus of medication being dispensed after which the user restarts the pump so that the plunger (35) is driven normally.



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Description

[0001] This invention relates to syringe pumps of the kind adapted to receive a syringe of the kind having a plunger movable along a barrel, the pump including an occlusion detector responsive to occlusion to flow of medication from the syringe.

[0002] Syringe pumps are used to supply medication to a patient from a pre-filled syringe via an infusion line. The syringe pump applies a force to the plunger of the syringe to drive medication into the infusion line at a controlled rate. It is common to have some provision to detect occlusion to flow of liquid out of the pump, such as caused by kinked tubing, and to respond to this by stopping the pump and sounding an alarm. The occlusion may be detected by measuring the force exerted on the plunger head by the pump driver, to detect excessive force. As described in GB2352637, the plunger head retainer itself may include a force sensor. The excess force produced until the occlusion is detected is accommodated by deformation of the elastic components, such as the fluid tubing and the syringe plunger head. When the pump is stopped, therefore, the medication fluid upstream of the occlusion is subject to compressive forces. When the occlusion is cleared, such as by straightening kinked tubing, the compressive force may cause a bolus of medication to flow to the patient. This can, in some situations, present a hazard to the patient.

[0003] WO97/07843 describes a peristaltic pump where the pump is reversed on detection of a possible occlusion and is then driven forwardly again before generating an alarm.

[0004] It is an object of the present invention to provide an alternative syringe pump and method of operation.

[0005] According to the present invention there is provided a syringe pump of the above-specified kind, characterised in that the pump is operable in response to a detected occlusion to reverse the drive applied to move the plunger along the barrel sufficiently to reduce excess force on the medication caused by the occlusion.

[0006] The occlusion detector preferably includes a force sensor and the pump may be arranged to reverse the drive until force detected by the force sensor reaches a predetermined level, such as substantially 10% of the force at which the occlusion is detected. The pump may be arranged to generate an alarm in response to a detected occlusion. The pump is preferably arranged to reapply force to dispense medication only after the pump is manually restarted after detection of an occlusion.

[0007] A syringe pump and its method of operation, according to the present invention, will now be described, by way of example, with reference to the accompanying drawing, which is a simplified view of the front of the pump.

[0008] The pump includes an outer housing 1 with a recess 2 on its front surface shaped to receive a syringe 3 of conventional kind. The syringe 3 has a cylindrical barrel 30 with an outlet or nose 31 at its forward end and a flange or ear 32 at its rear end. The nose 31 is connected to an infusion line 5 so that a medication liquid in the syringe 3 can be dispensed to a patient via the infusion line, by pushing in the plunger 35. The pump has a drive mechanism 7, including a lead screw 8 driven by an electric motor 9. A retainer mechanism 10 is movable along the lead screw as it rotates and engages the head 36 of the plunger 35, so as to move the plunger along the barrel 30. The motor 9 is driven by a control unit 11, which receives inputs from a keypad 12, or other user input means, and various sensors. The control unit 11 also provides an output to a display 13.

[0009] The plunger head retainer 10 includes a force sensor 20, as described in greater detail in GB2352637, which responds to the force exerted on the plunger head 36 by the retainer and provides an output to the control unit 11. The control unit 11 includes a memory 110 containing information as to an upper, maximum predetermined value of force F_{max}. If this force is exceeded, it indicates an obstruction to forward movement of the plunger, which is usually caused by an occlusion in the path of medication from the syringe. The force sensor thereby operates as an occlusion detector. Most commonly, such an occlusion would be caused by a kink in the infusion line 5 but it could be caused, for example, by inadvertent use of a clamp on the tubing or by a blood clot where the medication enters the patient.

[0010] The control unit 11 compares the output from the sensor 20 with the contents of the memory 110 and, if the force exceeds F_{max}, it provides an alarm signal, such as an audible alarm and a warning indication on the display panel 13. The control unit 11 also stops forward drive by the motor 9 and applies signals to drive the motor in reverse until the force detected by the sensor 20 reduces to some level above zero, typically about 10% of F_{max}. At the same time, when this reduced level of force is detected, the control unit 11 stops drive to the motor 9 until the user clears the occlusion and manually restarts the pump. The force applied to the medication is considerably reduced compared with what it would be if the motor had been simply stopped on detection of the occlusion. Thus, when the occlusion is removed, such as by straightening kinked tubing, there will be no significant bolus of medication dispensed to the patient. The force on the plunger is preferably maintained slightly above zero in order to ensure that there is no reverse flow of medication along the infusion line when the occlusion is removed.

Claims

1. A syringe pump adapted to receive a syringe (30) of the kind having a plunger (35) movable along a barrel (30), the pump including an occlusion detector (20) responsive to occlusion to flow of medica-

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tion from the syringe, **characterised in that** the pump is operable in response to a detected occlusion to reverse the drive applied to move the plunger (35) along the barrel (30) sufficiently to reduce excess force on the medication caused by the occlusion.

2. A pump according to Claim 1, **characterised in that** the occlusion detector includes a force sensor (20).

3. A pump according to Claim 2, **characterised in that** the pump is arranged to reverse the drive until force detected by the force sensor (20) reaches a predetermined level.

4. A pump according to Claim 3, **characterised in that** the pump is arranged to reverse the drive until force detected by the force sensor (20) is substantially 10% of the force at which an occlusion is detected.

5. A pump according to any one of the preceding claims, **characterised in that** the pump is arranged to generate an alarm in response to a detected occlusion.

6. A pump according to any one of the preceding claims, **characterised in that** the pump is arranged to reapply force to dispense medication only after the pump is manually restarted after detection of an occlusion.

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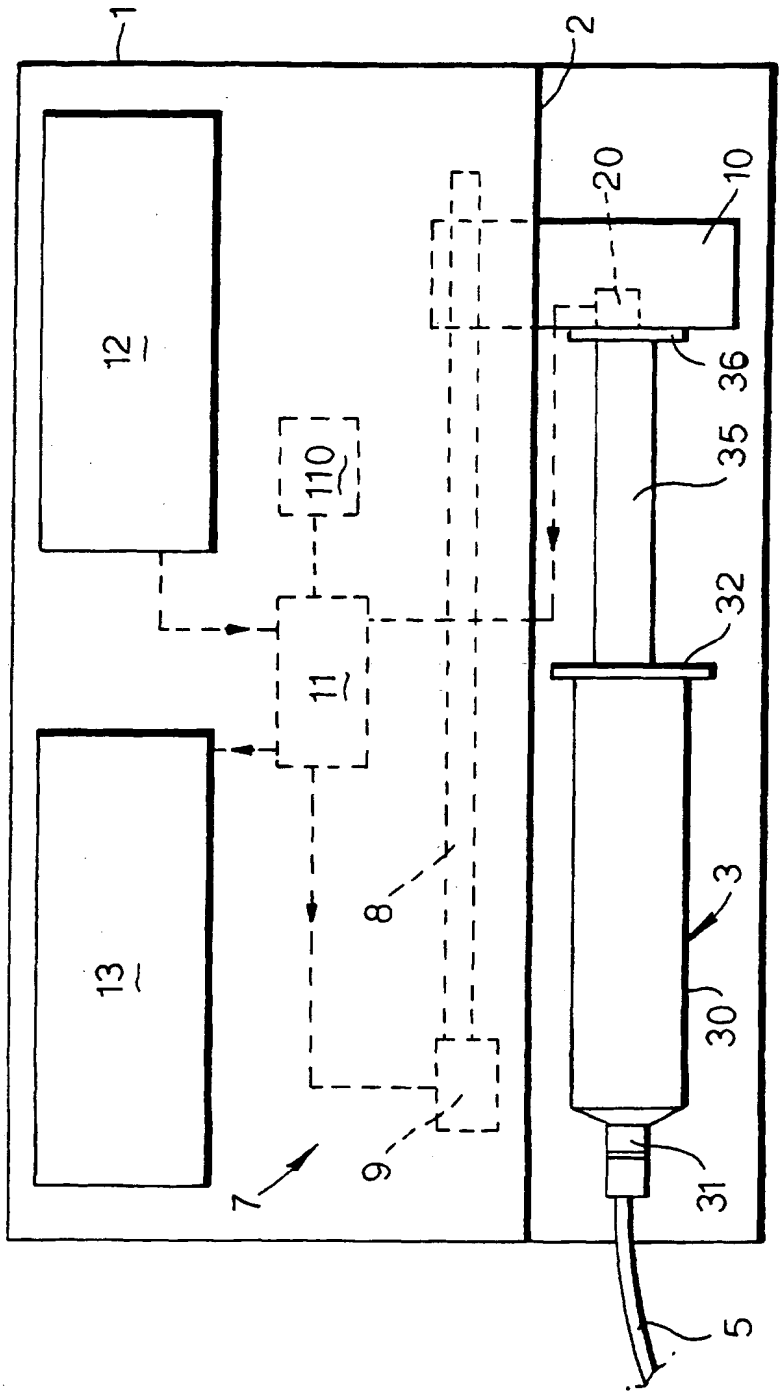

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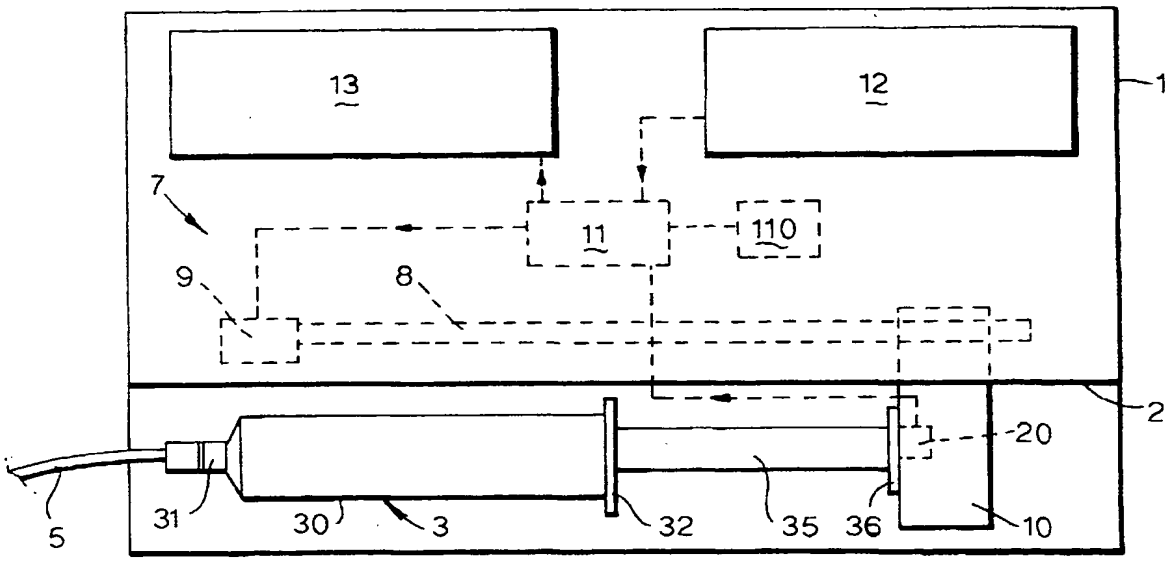

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EUROPEAN SEARCH REPORT

Application Number
EP 01 30 6557

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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

A61M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	24 January 2002	Ehrsam, F

CATEGORY OF CITED DOCUMENTS

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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